Maestría en Ingeniería en Automatización de Procesos Industriales

Title

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ROTOMOLDING PROCESS AUTOMATION FOR THE MANUFACTURE OF HOLOW PLASTIC PRODUCTS

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1. Introduction

Industrial Automation IA is the discipline that pursues the autonomous operation of technical devices; nowadays it is invariably software based and realized by means of a Programmable Logic Controllers (PLC). General methods applied in the industry are intuitive rather than being formal. For small-sized Discrete Event Dynamic Systems (DEDS) control problems, intuitive methods may yield practical solutions, but as the controlled system gets larger and complex, formal methods need to be applied.

This work is an approach between IA to the rotomolding process, known also as rotational molding or rotocasting. Rotomoldig is a process for manufacturing hollow plastic products. The process consists of introducing a known amount of plastic in powder; The mold is rotated about two principal axes at relatively low speeds as it is heated so that the plastic enclosed in the mold adheres to, and forms a monolithic layer against, the mold surface. The mold rotation continues during the cooling phase so that the plastic retains its desired shape as it solidifies. When the plastic is sufficiently rigid, the cooling and mold rotation is stopped to allow the removal of the plastic product from the mold.

2. Aim

Automate the process of rotational molding, considering the stages of transformation of the polymer for the manufacture of plastic products

Specific goals.

1. Identify the rotational molding process to figure out parameters and operating ranges.

2. Implement systems for monitoring and actuating the rotational molding process.

3. Implement the sequential control to set automatic procedures.

3. Method

First stage.

Requirements engineering process: at this stage the general operation of the machine to automate is defined, this part is done by visiting the company related to the project in order to collect information and make some interviews with of improve design team of the new process machine.

Second stage.

Graph-based modeling system using Finite Automata (FA) and Sequential Function Chart (SFC), the latter one is defined by the international standard IEC-61131.

Third stage

Convert the graph model to Ladder Diagram.

Fourth stage.

Instrumentation of equipment's, test's & fit.

4. Results

The process diagram illustrated on Figure 1 and the flowchart of Figure 2 describes the operation of automatism

Figure 3 illustrates the model automation techniques using graphs; in a) use of finite automata, in b) the main SFC illustrated based on GEMMA guide, in c) illustrate part of sequential function chart SFC for F1 normal production step described in c.

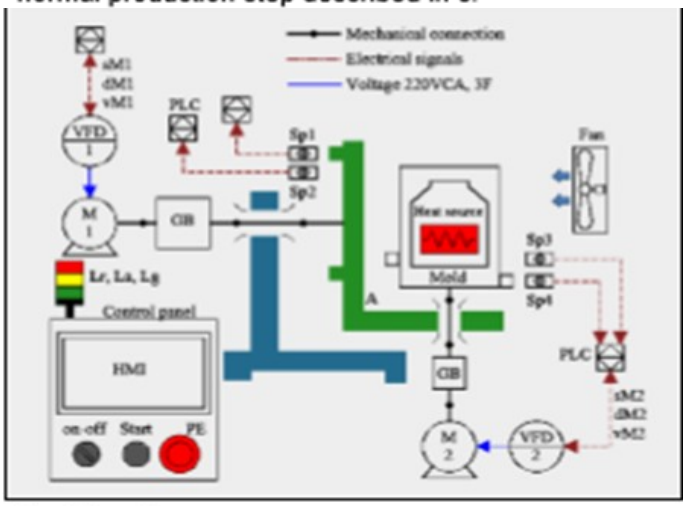


Figure1. Process diagram.

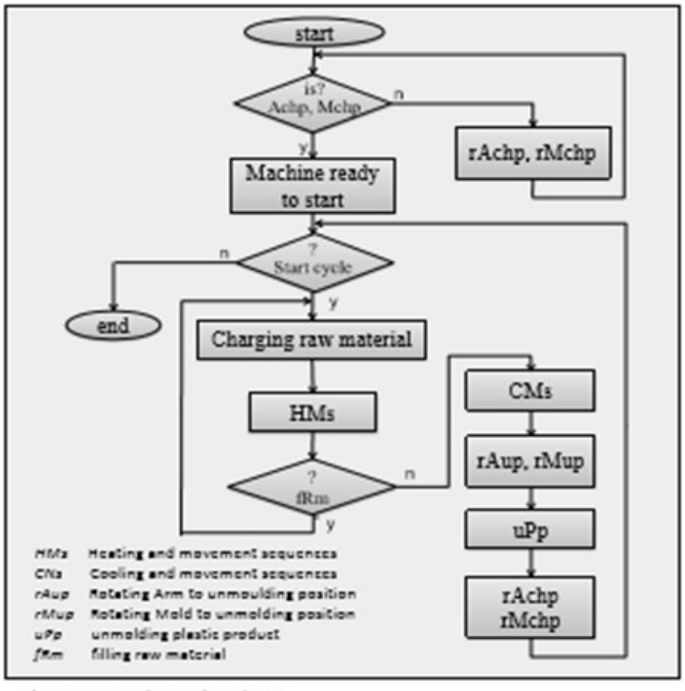


Figure 3. General operation scheme.

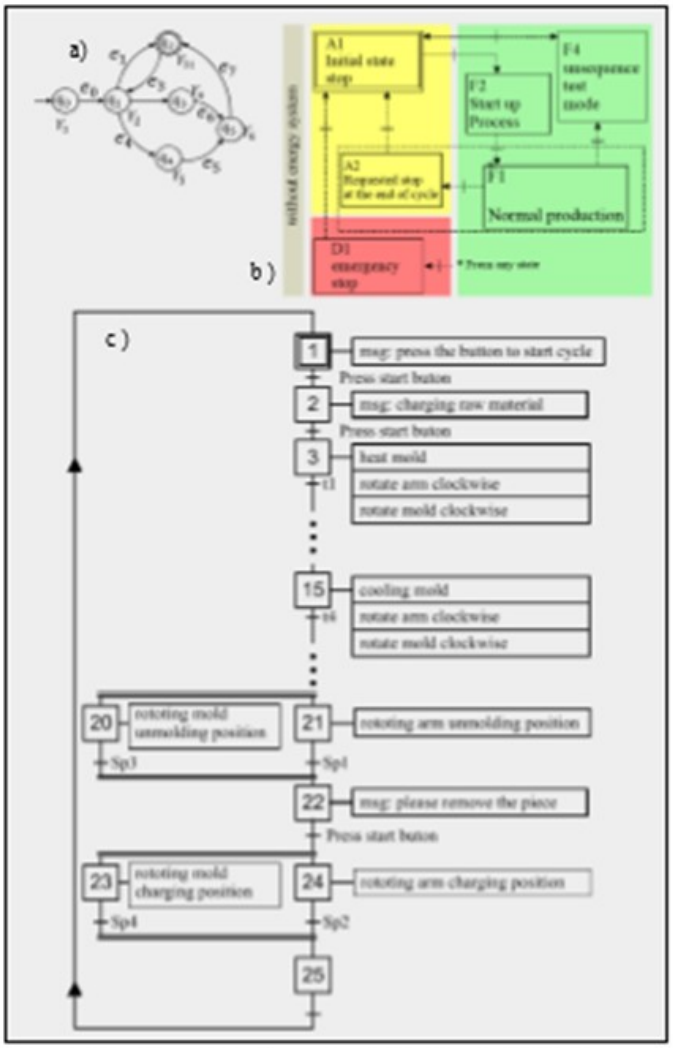


Figure 3. Automatic model based on graphs. a) Finite automaton, b) GEMMA c) Sequential function Chart level 1

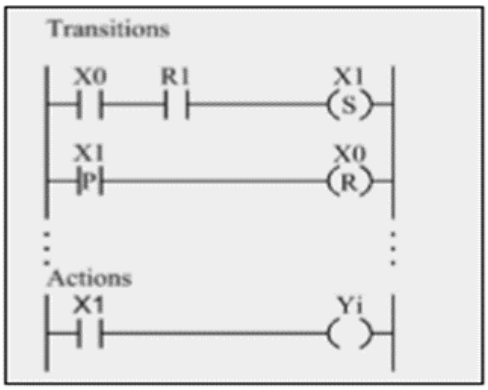


Figure 4. Transition program on ladder

The Figure 4 illustrate the way to convert transitions functions on ladder diagram. For each corresponding transition on the model graph given by:

$$\delta(q_0, e_1) = q_1$$

Where:

X0 = q_0 (previus state)

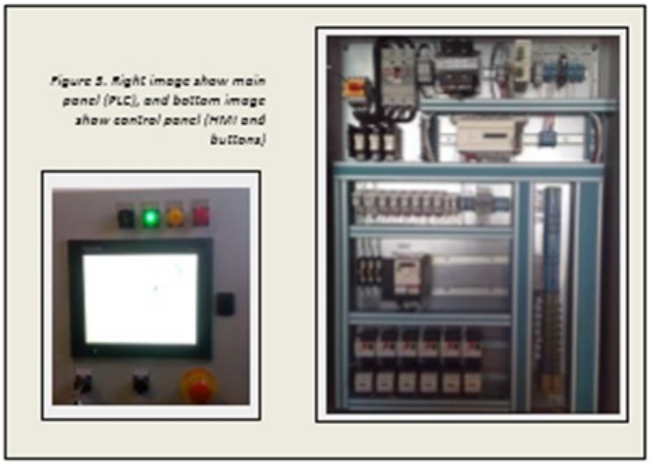
X1 = q_1 (next state)

R1 = e_1 (event)

Yi actionts to do while state q_1 is active

Figure 5 illustrates the implementation of the main control panel and the HMI panel, which was installed on the existing machine ground.

Figure 5. Right image show main panel (PLC), and bottom image show control panel (HMI and buttons)



5. Conclusion

In this work concludes that the use of formal methods for modeling discrete event dynamic systems, particularly AF and SFC, facilitate the implementation of programs in language contact schemes, and improve their understanding. Because the graph model works as a descriptive engineering support, which allows no problem locating each stage of evolution of the system, its location within the program code and thus facilitate its maintenance and implementation of new functionalities or modifications to existing ones.

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